

TITLE: SEVERE STORM ELECTRICITY

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SIGNIFICANT ACCOMPLISHMENTS FY 84

During FY84, we have conducted a field program and analyzed data from previous years and from the spring of 83. The field program utilized coordinated measurements made with a NASA U2 and ground based facilities, both fixed-base and mobile. Aspects of this program are also reported by S. Goodman and R. Arnold elsewhere in this review. Portions of these and other efforts with which we were involved during the past year have yielded the following:

1) ground truth measurements of lightning for comparison with those obtained by the U2. These measurements have included flash type identification, electric field changes, optical waveforms, and ground strike location. Both sensors at NSSL and on the UM/NSSL mobile laboratory (see R.T. Arnold report) were used.

2) simultaneous ELF (extremely low frequency) waveforms at NSSL and MSFC for cloud-to-ground (CG) flashes. These are being used not only for flash identification but also examined for possible future combination with data from the proposed satellite lightning mapper.

3) an assessment of our CG strike location system (LLP) using a combination of mobile laboratory and NSSL television video data. This project is a few weeks from completion and now allows us to provide much more accurate locations of CG locations for comparison with the U2 data and for other storm research.

4) continued development of analog-to-digital conversion techniques for processing lightning data from the U2, mobile laboratory, and NSSL sensors. This hardware/software project is still underway, but already it has increased significantly our ability to look at large numbers of flashes. For example, we were able to study all flashes obtained at the U2 and the ground during the 3 June 83 flight chosen for analysis, not just a small percentage as in previous years. In addition the multi-channel capability allows us to compare easily various waveforms obtained simultaneously from the same flash, eg., field change and optical waveforms.

5) completion of an all-azimuth TV system for CG ground truth

6) a preliminary analysis of both IC and CG lightning in a mesocyclone (parent circulation of a tornado). We confirmed again our previously found relationship that CG activity increases after peak MC strength. In addition, we find the IC activity appears to peak at approximately the same time that the MC strength is a maximum.

7) the finding of a bimodal peak in altitude lightning activity in some storms in the Great Plains and on the east coast. In the storms on the Great Plains, there was a distinct class of flash that formed the upper mode of the distribution. These flashes had smaller horizontal extent, but occurred much more frequently than flashes in the lower mode of the distribution.

#### FOCUS OF CURRENT RESEARCH ACTIVITIES:

We currently are completing preparations for the 1984 spring research program, with the U2 participating from mid-May to early June. A significant part of this program will be simultaneous data collection with sensors at NSSL, aboard the U2, and on the mobile laboratory. We anticipate completion in the near future of our analysis of site errors in our CG location network. We are completing our study of CG lightning in severe storms with a strong mesocyclone.

#### PLANS FOR FY 85:

We anticipate increased emphasis upon the combination of large meteorological and electrical data sets through cooperative work with MSFC as we explore interrelationships among electricity, precipitation, and air motions within severe storms. As data handling capabilities increase significantly at both locations, we anticipate being able to produce more case studies of severe storms. Other topics of ongoing research include positive CG flashes, continued evaluation of the ground strike locating system, particularly its ability to locate positive CG flashes.

#### RECOMMENDATIONS FOR NEW RESEARCH

We plan to expand our efforts to include identification of important scientific experiments that can best, or only, be conducted by using satellite mapper data to make a portion of the necessary measurements. Examples could include mapping of the horizontal progression of lightning that extends more than a hundred kilometers and the study of severe hail storms that produce mostly intracloud lightning. These latter plans are contingent upon renewal of our research proposal, which is currently in the review process.

## PUBLICATIONS SINCE JUNE 1983:

### Refereed

"Lightning flash density versus altitude and storm structure from observations with UHF- and S-band radars", Vladislav Mazur, J.C. Gerlach, and W. David Rust. Geophys. Res. Ltrrs., 11, (1), 61-64, Jan. 1984.

"Positive cloud-to-ground lightning", W. David Rust. Submitted as a chapter in The Atmospheric Electrical Environment, Studies in Geophysics, National Academy of Sciences, 1983.

"Lightning activity and severe storm structure", William L. Taylor, Edward A. Brandes, W. David Rust, and Donald R. MacGorman. Accepted for publication in Geophys. Res. Ltrrs. 1984.

### Unrefereed

"Lightning activity observed in upper and lower portions of storms and its relationship to storm structure from VHF mapping and Doppler radar", William L. Taylor, W. David Rust, Donald R. MacGorman, and Edward A. Brandes. Preprints, 8th Inter. Aerosp. and Ground Conf. on Lightning and Static Elec., Ft. Worth, TX, June 21-23, 4-1 - 4-9, 1983.

"Lightning flash density versus altitude and storm structure from observations with UHF- and S-band radars", Vladislav Mazur, J.C. Gerlach, and W. David Rust. Preprints, Inter. Aerosp. and Ground conf. on Lightning and Static Elec., Ft. Worth, TX, June 21-23, 1983.

"Cloud-to-ground lightning in tornadic storms on 22 May 1981", Donald R. MacGorman, W. David Rust, and William L. Taylor. Preprints, 13th Conf. on Severe Local Storms, Oct. 17-20, Tulsa, OK, 197-200, 1983.

"Relationships between lightning activity and severe storm structure from VHF mapping and Doppler radar", William L. Taylor, Edward A. Brandes, W. David Rust, and Donald R. MacGorman. Preprints, 13th Conf. on Severe Local Storms, Oct. 17-20, Tulsa, OK, 201-204, 1983.

"Cloud-to-ground lightning in the mesocyclone region of severe storms", S. Horsburg, R.T. Arnold, and W.D. Rust. Preprints, 13th Conf. on Severe Local Storms, Oct. 17-20, Tulsa, OK, 205-206, 1983.

"Positive cloud-to-ground lighting in severe storms and squall lines", W. David Rust, Donald R. MacGorman, and R.T. Arnold. Preprints, 13th Conf. on Severe Local Storms, Oct. 17-20, Tulsa, OK, 211-214, 1983.

"Lightning activity and mesocyclone evolution, 17 May 1981", Donald R. MacGorman, Vladislav Mazur, R.T. Arnold. (Abstract) EOS, 64, (45), November, p. 662, 1983.